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Growth performance and mortality rate of Abera sheep under different management systems in Sidama Regional State, southern Ethiopia

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ABSTRACT

Knowing the performance of sheep under different management settings is an important tool for recommending a suitable and profitable breeding program. The current study assessed the growth and mortality rate of Abera sheep under different management conditions (on-farm versus station) in the Dara Otilcho district of Sidama regional state. On-station data of sheep monitored at Abera Gelede sub research station (n = 105) and on-farm data of sheep owned by households in Abera Gelede breeder villages (n = 284) were collected between 2018 and 2020. Body weight at birth, weaning age (90 days), six-months (180 days), and yearling age were growth traits considered. Pre-weaning and post-weaning body weight gain was also estimated. A linear model of the Statistical Analysis System (SAS) was used to analyze growth traits. The result showed sheep managed under farmers' conditions were significantly ($p < 0.001$) superior to their on-station counterparts for all growth traits except at weaning age and pre-weaning average daily weight gain. The least square mean of sheep managed under farmers' management conditions at birth, weaning age, six-month age, and yearling age, pre-weaning average daily weight gain and post-weaning average daily weight gain was 3.43 kg, 14.99 kg, 19.09 kg, 28.87 kg, 119.44 g/day and 56.84 g/day, respectively, whereas the corresponding value for on-station sheep was 3.14 kg, 13.86 kg, 18.15 kg, 25.02 kg, 116.04 g/day and 47.53 g/day. Sheep managed under farmers' conditions were found to be more prolific than on-station managed sheep. A higher mortality rate (14.15%) was recorded for on-station managed sheep compared with the 7.67% mortality rate recorded under farmers' management condition. Generally, the present study concluded that sheep managed at a farmer's condition had a better growth rate and lower death rate than their on-station counterparts, which indicates sheep production is more profitable under a farmer's management condition in the area.

Keywords: Abera sheep, growth rate, mortality rate, on-farm, on-station.

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INTRODUCTION

Small ruminant production constitutes an integral portion of livestock agriculture in Sub-Saharan Africa (Kosgey et al., 2008). It has a considerable contribution to the livelihood of smallholder farmers. They are considered a key farmer's asset and have a significant contribution to the household's food security and income at large (Assefa, 2007; Kocho, 2007). Sheep production as part of small ruminant production has a great role for farmers. Sheep provide smallholders and the rural poor with immediate cash earnings, animal foods (meat), manure, raw materials (skins), and indirect benefits such as savings and protection against disasters, along with other socio-economic and cultural functions (Welday et al., 2019). Sheep production in Ethiopia is believed to be the second most important livestock species to farmers and is reared in different agro-ecologies and represented by different breeds and ecotypes across Ethiopia (Gemeda, 2010). Small ruminant production constitutes an important component of livestock production for small holders in many developing countries. They provide a

wide range of benefits to smallholder farmers, including immediate cash income, meat, milk, skin, and manure (Kosgey et al., 2006; Welday et al., 2019), means for risk management, and have a notable contribution to foreign currency generation (Gebremedhin et al., 2006).

Ethiopia has a large population of small ruminants, estimated at 95.4 million, with sheep accounting for approximately 42.9 million (CSA, 2021). These sheep populations are represented by diverse genetic resources and are raised in a variety of agro-ecological conditions across the country (Gizaw, 2008). Approximately 99.52% of these sheep are indigenous, with the remaining 0.41 and 0.08% being hybrid and exotic, respectively (CSA, 2021).

Sheep production has become an important component in mixed crop-livestock production systems in most highland parts of Sidama Regional State. Abera sheep represent the dominant indigenous sheep type widely reared in the Hula and Dara districts of the region. Abera sheep are mainly kept for meat production and are characterized by long fat-tails with straight tips, short and smooth hairs, and straight head profiles (Melesse et al., 2013). Since 2013, a community-based breeding program (CBBP) has been implemented for the mentioned sheep types, and eight breeder cooperatives have been established since then. Abera Gelede breeder cooperative is one among the other eight breeder cooperatives where Abera sheep improvement and multiplication center (Abera Gelede sub-research station) are located. In 2018, ewes of Abera sheep were introduced to Abera Gelede sub-research station to investigate their growth performance under station conditions. As part of a community-based breeding program, growth and reproductive data were collected with well-trained enumerators under both on-farm and station conditions. Performance monitoring of sheep under different management is an important tool for recommending suitable and profitable improvement options (Deribe, 2009). No research work so far has evaluated the growth and reproductive performance under different management settings. Therefore, the present study was conducted with the objective of evaluating the performance of sheep under different management conditions using available performance records.

MATERIALS AND METHODS

Description of the study area

The study was conducted at Abera Gelede sub-station the center for improvement of Abera sheep which found in the Dara Otilcho district of Sidama Regional State. Abera Gelede station is located around 100 km away from Hawassa city, a regional city, and 375 km away from Addis Ababa, the capital city of Ethiopia. The latitudinal and longitudinal location of the district is 6°29'59.99" N and 38°24'59.99" E, respectively. A mixed crop-livestock production system is the dominant livelihood system for a community.

Management of experimental animals

On-station sheep

Ewes of the Abera sheep population owned by participants of the Abera community-based breeding program were purchased to investigate their performance at Abera Gelede sub-research station during the 2018–2020 period. A total of 32 breeding ewes were introduced to the station. At the beginning of the study, two breeding rams from a community-based breeding program were chosen for a controlled mating scheme with the ratio of one male to 16 ewes. A semi-intensive feeding system was provided for the station's managed sheep. Sheep were grazed on the natural pasture available at the station for 8–9 hours a day. Improved forages such as Desho grass (*Pennisetum pedicellatum*) and tree lucerne were also established in the station. During feed scarcity, animals were supplemented with concentrates and given free access to water. Lambs were allowed to nurse their dams from birth until weaning age and then began to feed on natural pasture. The sheep were sheltered in a house made of iron sheets, and the floor was cemented. Permanent ear tags were used to identify animals where their body weight was taken immediately after birth, at weaning age, at six-months and yearling age. Animals were regularly monitored for their health status and necessary treatment was administered, including internal and external parasites.

On-farm sheep

Traditional feeding management was provided for sheep managed under the farmers' conditions. Natural grazing pasture was the main feeding source of on-farm sheep. During dry seasons where feed shortages become a problem, sheep are allowed to feed on crop residues after crop harvest. Through awareness gained from the policy of community-based breeding programs (CBBP) in the area, some CBBP households started establishing improved feed resources like Desho grass, which is used as supplementary feed during times of feed shortage. House waste leftovers were also an additional feed source for on-farm sheep. Sheep were sheltered in traditional houses made up of available local materials like bamboo and others. When animals get sick, farmers either take them to a veterinary service delivery point or purchase drugs. Permanent plastic ear tags were used to identify the animals as per the policy of CBBP. Body weight for growth traits was recorded using a weighing

balance having a capacity of 50 kg, where animals were suspended in the sack.

Types and source of data

Productive and reproductive data on sheep were obtained from the Southern Agricultural Research Institute. This data was collected and stored between 2018 and 2020 for sheep owned by Abera community-based breeding program participants' households in Abera Gelede breeder cooperatives and on-station sheep managed at Abera Gelede sub-station. Permanent plastic ear tags were used to identify sheep under monitoring. The total number of records (on-farm versus on-station) was 389 (284 versus 105) at birth, 308 (249 versus 59) at weaning age, 266 (212 versus 54) at six-month age, and 114 (96 versus 18) at yearling age, respectively collected for growth data analysis. Sheep prolificacy (number of lambs born at birth) and mortality of sheep recorded during 2018–2020 were also used for analysis.

Data management and statistical analysis

All the data collected was entered and managed using the Microsoft Excel computer program. The data was analyzed using the Statistical Analysis System version 9. The least square mean was estimated by fitting the management condition (on-farm versus on-station) as effect fixed effects for growth traits.

Descriptive statistics such as percentage (%) were used to present the sheep prolificacy rate, mortality rate, and sex ratio. A chi-square test was employed to test the independence of sheep management conditions with regard to sheep prolificacy, mortality rate, and sex ratio. Pre-weaning average daily weight gain (PrADWG) here represents the age between birth and 90 days, and post-weaning average daily weight gain (PoADWG) represents 90 days to 180 days and is calculated as follows:

$$\text{PrADWG (g/day)} = \frac{Body\ weight\ at\ weaning\ age\ (90\ days) - body\ weight\ at\ birth}{90} \times 1000$$

$$\text{PoADWG (g/day)} = \frac{Body\ weight\ at\ six-month\ age\ (180\ days - body\ weight\ at\ weaning\ (90\ days)}{90} \times 1000$$

Mortality rate (%) was calculated as number of died out total lamb born multiplied by 100 and explained as follows:

$$\text{Mortality rate (\%)} = \frac{Number\ of\ lamb\ died}{Total\ number\ of\ lamb\ born} \times 100$$

$$\text{Prolificacy (\%)} = \frac{Twin\ or\ triple\ birth\ recorded}{Total\ number\ of\ birth\ recorded} \times 100$$

RESULT AND DISCUSSION

Productive performance

Birth weight

The birth weight (least square mean ± standard error) of Abera sheep in different management conditions is presented in Table 1. Overall, the least square mean of 3.37 kg of Abera sheep was highly significantly ($p < 0.001$) different between on-farm and station-managed sheep. On-farm sheep were heavier by 0.29 kg on average than station-managed counterparts (3.43 kg versus 3.14 kg). The notable difference in the body weight of sheep at birth could be associated with differences in management conditions such as availability of feeding resources, housing types, and other related managerial issues. Continuous farm visits and observations revealed that sheep at the station experienced severe feed shortages during dry seasons when compared to sheep managed under farmer conditions, where more feeding resources (crop residues, homemade wastes) are available for ewes during pregnancy periods. The growth rate of station sheep during pre-natal periods would have been affected by a cement floor without bedding materials and a low night time temperature. The birth weight performance of sheep recorded in the present study was higher compared with previous reports for different sheep breeds such as Gumuz sheep (1.62 kg; Amare, 2018); Washera sheep (2.16 kg; Asmare et al., 2021); indigenous Wollo highland sheep (Amare, 2018) and Bonga sheep (Shenkute, 2009). However, the birth weight performance of sheep in the present study was lighter than that reported for desert Rutana sheep (3.71 kg; Dagnew et al., 2018) and Balami sheep breed reared in the semi-arid region of Nigeria (3.55 kg; Momoh et al., 2013). The birth weight of Bonga sheep (3.4 kg; Haile et al., 2014) managed under a community-based breeding program was comparable with corresponding on-farm performance and higher than

Table 1. Least square means ± standard error of body weight at birth, weaning age, six-months and yearling age of Abera sheep under different management conditions.

Management condition	BW	WW	SM	Yearling weight
	LSM ± SE (kg)	LSM ± SE (kg)	LSM ± SE (kg)	LSM ± SE (kg)
Overall	3.37 ± 0.02	13.99 ± 0.08	18.92 ± 0.09	28.35 ± 0.20
On station	3.14 ± 0.04	13.86 ± 0.15	18.15 ± 0.2	25.02 ± 0.48
On farm	3.43 ± 0.02	14.02 ± 0.09	19.09 ± 0.1	28.87 ± 0.19
p-value	<0.001	0.4550	0.003	<0.001

BW – birth weight, WW – Weaning weight, SM – Six month weight, LSM – Least square mean, SE- Standard error.

station one recorded in the present study. The reported difference in birth weight performance among many sheep breeds could be attributed to the difference in management systems besides the genotypes of breeds.

Weaning age

The growth rate of sheep at weaning age (90 days) is an important economic trait determining sheep productivity and the mothering ability of ewes. The weaning weight of Abera sheep under different management conditions is presented in Table 1. Weaning weight of sheep managed under farmers' conditions was comparable ($p > 0.05$) with those managed at the station; however, on the farm, sheep were numerically heavier by 0.16 kg on average than station managed. This comparable body weight of sheep at 90 days between management conditions would be associated with comparable milk production ability for ewes to gestate the lambs. Higher weaning weight was observed from previous reports for different sheep breeds such as Bonga, Washera, and Gumuz sheep (Asmare et al., 2021; Taye et al., 2010) managed under different management conditions. In contrast to the results of the current study, lower weaning weight performance was recorded by previous studies; 7.95 kg for sheep managed under traditional management conditions around the Fantale area of Oromia regional state (Worku et al., 2019), 11.9 kg for Sekota sheep (Yeheyis et al., 2012), 12.03 kg for the same sheep breed under traditional management system (Marufa et al., 2017), and 12 kg for Horro sheep managed at station condition (Haile et al., 2014). The weaning weight difference of different sheep breeds across locations could be attributed to the difference in management systems, among other factors.

Sixth-month weight

Body weight of sheep at 180 days managed under farmers' management conditions and station level is presented in Table 1. Overall, the least square mean (18.92 kg) of Abera sheep at 180 days was significantly ($p < 0.01$) different between on-farm and station management conditions (19.09 kg versus 18.15 kg). The result indicated that on-farm managed sheep were heavier by 0.94 kg on average than their station counterparts. This notable difference would be attributed to the difference in management conditions. Higher body weight sheep under farmers' management conditions would be the result of more readily available feeding resources than in stations where feed resources are scarce, mainly during dry seasons. Lack of sustainability in supplying concentrated feed as expected would reduce the growth rate of sheep at station conditions. The observed result of body weight at 180 days was heavier compared with previous reports; 13.94 kg for Washera sheep; 12.16 kg for Gumuz sheep; and 11.81 kg for indigenous sheep reared by small-holder farmers in the Fentale area of Oromia Regional State (Worku et al., 2019). 180-day growth performance of Rutana desert sheep (18.93 kg; Dagnew et al., 2018) was nearly comparable to the on-farm corresponding value in the present study and slightly higher than the value recorded for station-managed sheep in the present study. Under community-based breeding programs, Bonga sheep had a higher 180-day body weight (22.2 kg) (Metsafe, 2015) than the corresponding value in the current study. Body weight differences among sheep breeds could be attributed to differences in management conditions and genotype performance differences.

Yearling weight

The result pertaining to the yearling weight of Abera sheep under the farmers' management conditions and the station is given 1. The overall least square mean of sheep at yearling age was 28.35 kg, which was significantly ($p<0.001$) different between different management conditions. Sheep managed under farmers' managed conditions were heavier by 3.85 kg on average than their station-managed counterparts. This difference is attributed to a difference in management conditions. The yearling weight of Washera sheep (21.3 kg; Asmare et al., 2021) and Gumuz sheep (21.8 kg; Asmare et al., 2021) was lighter than the reported corresponding value in the present study. The yearling weight (15.82 kg) of indigenous sheep around Fentale area under traditional

management conditions was far lighter compared with the yearling weight of sheep in the present study (Worku et al., 2019). On-station yearling weight of the Menz sheep (17.1 kg) and Horro sheep (19 kg) by Markos (2006) was similarly lower compared with the corresponding value of the station sheep in the present study. The yearling weight of Afar sheep (24.5 kg; Yacob, 2008) managed at the station level was nearly comparable with the current report. Yacob (2008) also found slightly lower yearling weight (23.7 kg) for Blackhead Somali under station management conditions.

Daily body weight gain

The results pertaining to average daily weight gain during pre and post-weaning periods of sheep under different management conditions were presented in Table 2. No significant ($p > 0.05$) daily weight gain difference was observed under the station and on-farm management conditions during pre-weaning periods. In disagreement with the results of the current study, the previous study (Amare et al., 2020) found heavier body weight gain in on-station managed sheep supplemented with concentrate feed during dry seasons. This may indicate a good opportunity to increase body weight gain provided that proper concentrate supplementation is given during dry seasons where feed shortages become a problem. The pre-weaning average daily weight gain recorded in the current study under different management conditions was higher than previous reports under the community-based breeding program; 80 g/day for Menz sheep, 90 g/day for Horro sheep (Haile et al., 2014), and 103.6 g/day for Doyo Gena sheep (Jimma et al., 2021), and slightly comparable with the report for Rutana desert sheep (118.05 g/day; Dagnew et al., 2018); which indicates the variation in daily weight gain of different sheep breeds managed under different management conditions.

The average daily weight gain of sheep differed significantly ($p < 0.01$) between the station and on-farm-managed sheep during post-weaning. Sheep managed under farmers' conditions gained a heavier average daily weight gain than their station counterparts by 9.3 g/day on average. This could be attributed to the difference in management conditions such as feeding and housing. Feed shortages during dry seasons and short supplies of concentrated feed might have caused a low body weight gain of on-station managed sheep during post-weaning periods. Post-weaning daily weight gain of sheep recorded in the present study was slightly lower compared to the previous report for Doyo Gena sheep (67.3 g/day; Jimma et al., 2021) and higher than the report for indigenous sheep reared in the Fentale area of Oromia region (43.01 g/day; Worku et al., 2019).

Table 2. Least square means ± standard of pre and post-weaning daily weight gain of Abera sheep between farmers and station management conditions.

Management condition	Average daily weight gain (gr/day)	
	Pre-weaning gain	Post-weaning gain
Overall	117.13 ± 0.79	55.19 ± 1.02
On station	119.44 ± 11.98	47.53 ± 15.63
On farm	116.04 ± 15.68	56.84 ± 18.17
p-value	0.1976	0.0005

Reproductive performance of Abera sheep

Litter size

The mean litter size of Abera sheep managed under different management conditions is given in Table 3. The mean litter size observed under on-farm conditions (1.26 ± 0.02) was significantly higher than the corresponding value for on-station (1.07 ± 0.02) managed sheep. Previous reports found higher mean litter sizes; 1.4 for Bonga sheep (Edea, 2008), 1.34 for Horro sheep (Abegaz and Awgichew, 2008), 1.43 for Gumuz sheep (Asmare, 2021), 1.42 for Adilo sheep (Getahun, 2008) and 1.51 for indigenous sheep around Alaba area (Deribe, 2009). The mean litter size recorded under farmers' management conditions in the present study was, however, higher than the corresponding value for Washera sheep (1.1; Mengiste, 2008), Gumuz sheep (1.17; Solomon, 2007) and Menz sheep (1.13; Mukasa-Mugerwa et al., 2002). Notably, difference in prolificacy rate across different management conditions in the present study could be attributed to the difference in management conditions. Mekuriaw et al. (2013) reported the management systems as major sources of variation for litter size where poor nutrition during service periods reduced ovulation rate and increased embryonic mortality, which ultimately caused lower litter size performance. Additional parity and age of ewes were reported among factors causing variation in litter size (Bela and Haile, 2009), where peak litter size performance can be achieved until parity five or age between four to eight years.

Table 3. Mean litter size ± standard error of Abera sheep between on-farm and station management condition.

Management condition	N	Mean ± SE	*p*-value
Overall	389	1.22 ± 0.02	0.0001
On station	96	1.07 ± 0.02	
On farm	293	1.26 ± 0.01	

N: stands for number birth records.

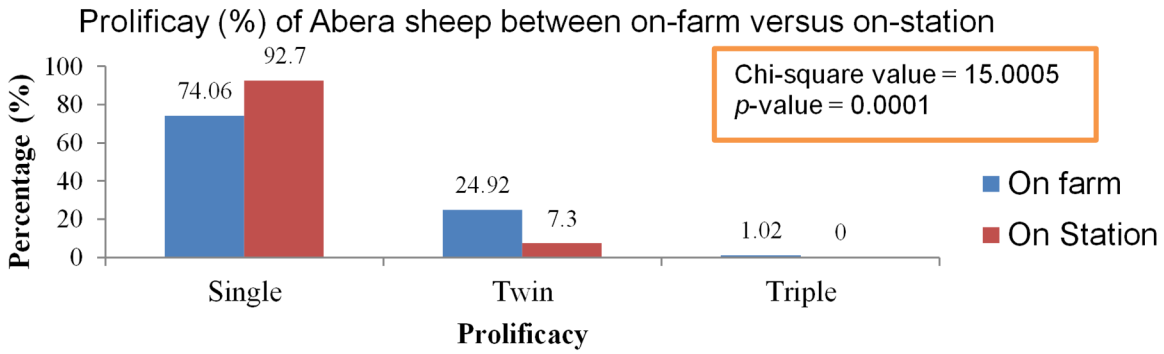

Figure 1. The proportion (%) of sheep gave birth to single, twin and triple between on-farm and station.

It was observed in the present study that sheep managed under farmers' conditions were significantly more prolific than those managed at a station (Figure 1; X^2 = 15.0005; p-value = 0.0001). The twining proportion of on-farm sheep (24.92%) recorded in the present study was higher compared with that of on-station sheep (7.30%). The on-farm twining rate of Abera sheep observed in the present study was lower compared with Bonga and Horo sheep (Edea, 2008), who reported 39.9 and 36%, respectively. The twining rate of indigenous sheep in Mareka (37.8%) and Konta area (39%) recorded by Amelmal (2011) was also higher than the on-farm twining rate in the present study, which is almost comparable with the twining rate of local sheep in Torcha (25%; Amelmal, 2011). The on-station twining rate of sheep recorded in the present study was lower than the 13.04% recorded for Begait sheep monitored at a government ranch (Gebregiorgis and Weldu, 2016) and nearly comparable to the 6.52% recorded for Begait sheep managed at a private ranch (Gebregiorgis and Weldu, 2016).

The majority (92.7%) of sheep managed at the station in the present study gave birth to singletons compared with 74.92% of on-farm managed sheep (Figure 1). The proportion of on-station managed sheep which gave singletons in the present study was higher than compared with Begait sheep (87%) managed in government ranches and comparable with 93% in private farms (Gebregiorgis and Weldu, 2016). Triple birth was rarely observed in station sheep, but it was observed in 1.02% of sheep managed under farmers' management conditions. The observed difference can partly be attributed to the difference in management between on-farm and on-station. Mekuriaw et al. (2013) indicated that the management system is the major source of variation for litter size differences.

Sex ratio

The male-to-female ratio of Abera sheep between on-farm and on-station management conditions was given in Table 4. The higher observed births were male under on-farm (56.51%) conditions, in contrast to the 38.94% recorded at the station level. Previous studies monitored the Begait sheep on government ranch and reported about 50.33% of male births (Gebregiorgis and Weldu, 2016), which was nearly comparable with the corresponding value under on-farm and higher than on-station management conditions in the present study. According to the chi-square test, the male-to-female ratio observed in the present study was different between the two management conditions (Table 4).

Mortality rate

The present study observed a higher mortality rate for sheep managed at station condition (14.15%) than sheep managed under a farmer's (7.67%) management condition (Table 4). The higher sheep mortality rate observed for on-station sheep could be attributed to

Table 4. Sex and mortality rate of sheep between on-farm versus on-station management condition.

Management	Total number of record	Sex ratio		Mortality rate (%)
		Male (%)	Female (%)	
On station	113	38.94	61.06	14.15
On farm	361	56.51	43.49	7.67
Chi-square value (X^2)		10.6519		4.3690
p-value		0.0011		0.0366

serious feed shortages during dry seasons. Haile et al. (2019) stated that feed scarcity and poor quality as major factors increasing lamb mortality. Gizaw et al. (2010) reported poor veterinary services delivery increase sheep mortality and ultimately reduces sheep productivity. Markos (2006) and Belete (2009) similarly mentioned the prevalence of disease and parasites as major production constraints of small ruminant production. The sheep mortality rate observed in the current study was higher than 7.04% of sheep mortality reported for indigenous sheep managed under traditional in the Wolaita area (Tifashe et al., 2017).

CONCLUSION

Sheep managed under farmers' management conditions had better productive and reproductive performance compared with their station counterparts. Further, a higher mortality rate was observed for station sheep compared with their on-farm managed counterparts. Therefore, the results of the current study suggest less encouragement for station-based livestock improvement activities under current management indicating on-farm-based improvement activities are more promising.

Conflict of interest

Authors declare that there are no conflicts of interest regarding the publication of this paper.

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